thus causing a corresponding drop in voltage. As the output voltage drops, the current-limit threshold also drops fractionally. The result is a decreasing output current as the voltage decreases; the limit is 0.2A at 1V of output. This foldback effect reduces power dissipation in the control device, which lets you use simple heat sinking.

When operating from a 6V raw supply, the rail-to-rail output drive from IC_{1B} can produce the full gate-source voltage and fully enhance (turn on) the PMOS transistor. The dropout voltage is 0.2V at 500 mA and 0.6V at 1A.

4- to 20-mA loop circuits

Amplifiers whose outputs swing close to the negative rail enhance and simplify the design of 4- to 20-mA loop transmitters. Amplifiers that can't swing close to this rail have saturation-voltage limits that reduce the accuracy of the amp's zero-scale signal range. The output—and many times the input—of an amplifier often operates at or near the negative rail, yet the amplifier must remain linear. A case in point is the circuit in **Fig 5**, a loop-powered strain-gauge sensor. The amplified 50-mV full-scale (FS) bridge output is calibrated for a 4- to 20-mA transmitter output.

IC_1 linearly amplifies the bridge signal by a gain of about 40. IC_1's output range includes the negative rail, so the IC can amplify a 0- to 50-mV bridge signal to 0 to 2.008V referred to the loop's common bus (pin 5 of IC_1). Because all negative-supply device pins refer to this point, the bulk of the loop's quiescent current flows into R_6 and the external loop and termination, R_{LOAD}.

With no output from the bridge, IC_1's output will be at the negative rail. No current flows through R_1 or R_2 into the summing point of IC_2 because IC_1 servos the summing point to the negative-rail potential. For this zero-scale signal condition, R_3 (4-mA NULL) calibrates the loop for a 4-mA output current or for 0.4V across R_{LOAD}. Because no current flows through R_1 in this zero-scale condition, R_1 has no effect on nulling, which ensures that the NULL and SPAN trims don't interact.

R_3 and R_4 effectively appear across the 5V reference output, so the current the reference injects into the loop is constant. The loop's output summing resistors, R_5 and R_6, scale the current. The expression for this current is

$$I_{NULL} \approx \left(\frac{5V}{R_3+R_4}\right)\left(1+\frac{R_5}{R_6}\right),$$

where 5V represents IC_3's reference voltage.

When the bridge output is 50 mV FS, IC_1 amplifies the output to the 2.008V FS level and supplies signal current to IC_2's summing point. Like the reference current through R_3 and R_4, the loop scales up the signal current in R_1 and R_2. The current appears

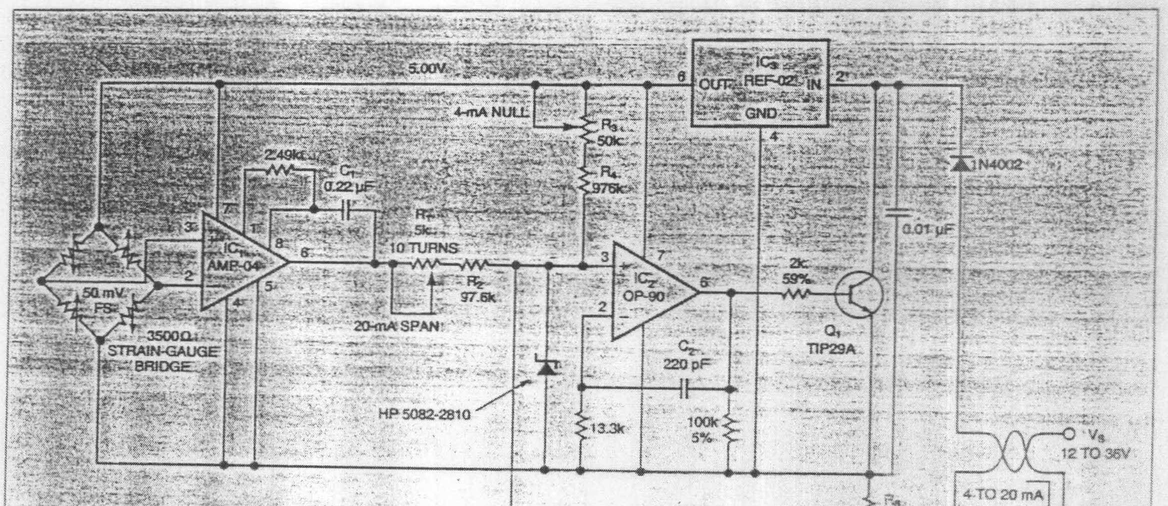

Fig 5—Single-supply amplifiers enhance the design of 4- to 20-mA current loops—such as this circuit, which features noninteractive trims—because the amplifiers can swing close to the negative rail and accurately amplify zero-scale signals.